**Determination of Sediment Thicknesses and Site Amplification Factors in the Salt Lake Valley, Utah, Using ANSS Data**

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**Investigations Undertaken (September 15, 2003 – September 30, 2004):**

The purpose of this project is to use data from the Advanced National Seismic System (ANSS) network in and near the Salt Lake Valley (SLV), Utah, to (1) measure low-strain site amplification factors for SLV soil sites and (2) determine thicknesses and average P/S velocity ratios for the near-surface SLV sediments. During the time period covered by this report, we concentrated our efforts on the first of these two goals.

**Results:**

Using data from the ANSS network in and near the SLV, we measured average, frequency-dependent, low-strain site-amplification factors for site-response units mapped by others on the basis of geology and near-surface shear-wave velocity. The site-amplification factors were determined using distance-corrected spectral ratios between horizontal-component ground-motion recordings from soil sites and reference rock sites. To test various models for the distance correction terms, we measured spectral ratios between recordings at 12 Paleozoic rock sites. These spectral ratios indicate that the ground motions decrease with hypocentral distance, r, at rates of $r^{-1.5}$ in the period range 0.4 to 2.0 sec and $r^{-2.0}$ in the period range 0.1 to 0.5 sec (Figure 1). We calculated the soil/rock spectral ratios using two different reference stations on Paleozoic rock. Geometric mean site-amplification terms for three SLV site response units were obtained by combining data from both reference stations. Comparing the resultant site-amplification factors to those of previous studies indicates that empirically based predictions better fit the observed data. Specifically, the empirically based site-amplification factors of Borcherdt (1994) and Boore and others (1997) fit the data better than the theoretically based factors of Wong and others (2002), even though the latter were developed specifically for the SLV site-response units (Figure 2).

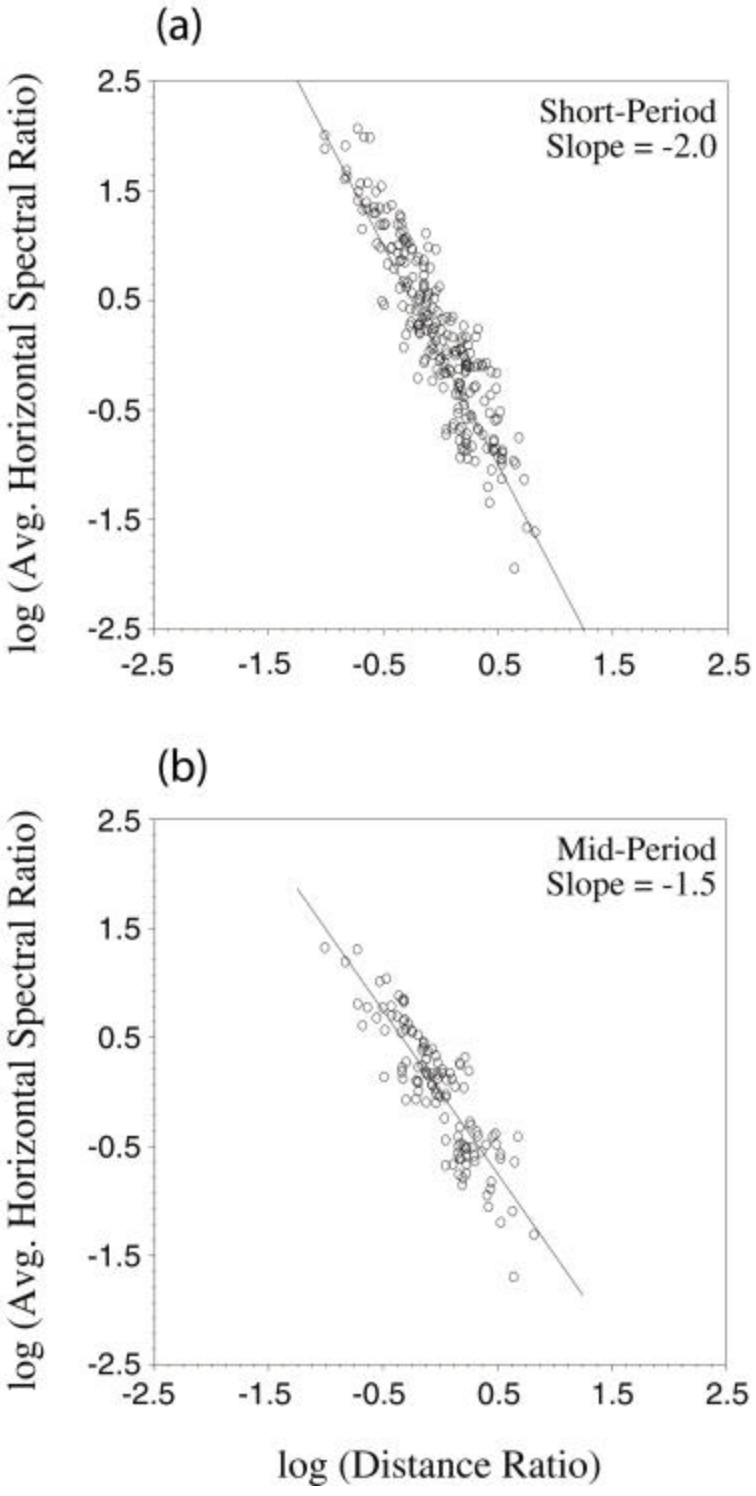


Figure 1. Observed spectral ratios plotted versus $\log_{10}$ (Distance Ratio), where the distance ratio is the ratio between the hypocentral distances of the two stations. (a) short-period band (0.1 to 0.5 sec) and (b) mid-period band (0.4 to 2.0 sec). The lines indicate fits to the data for an exponential model.

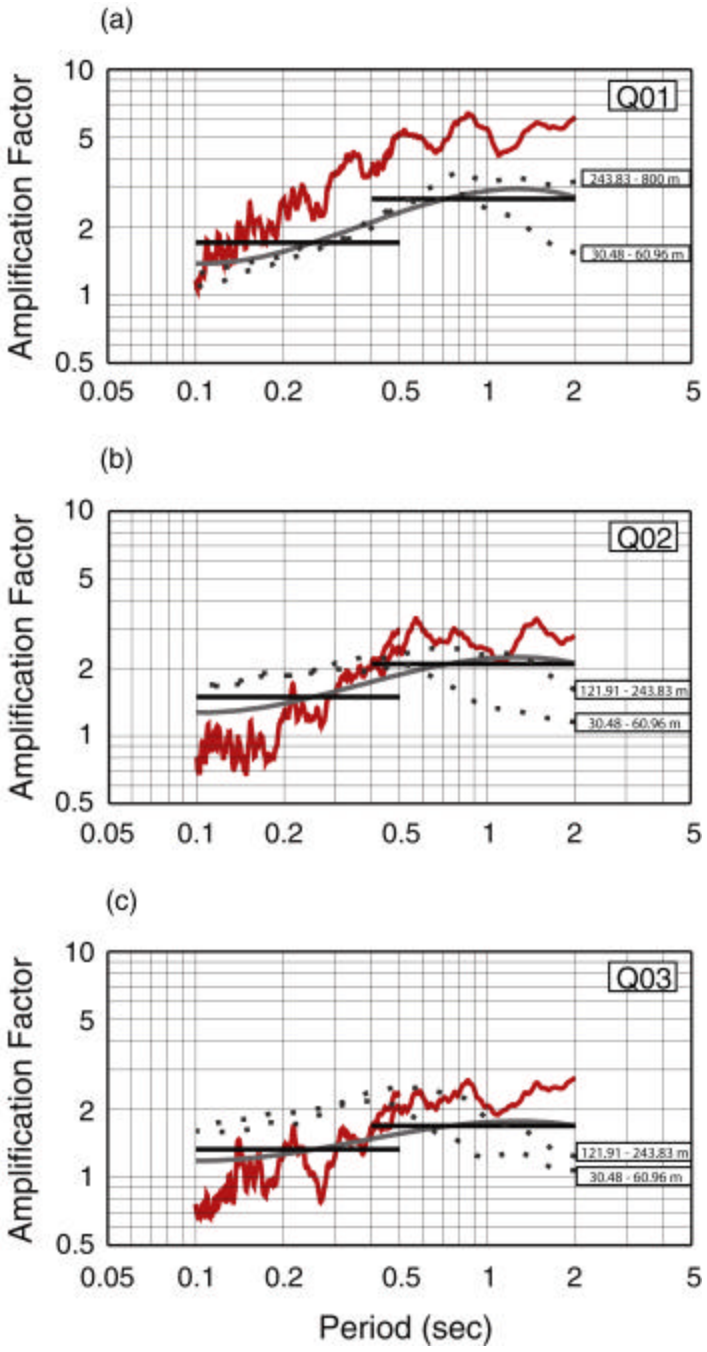


Figure 2. Observed (red) and predicted (black and gray) site-amplification factors as a function of period for three different SLV site-response units. The observed amplification factors are geometric means (solid red lines) from this study. The predicted amplification factors from Borcherdt (1994, solid black lines), for rock peak acceleration 0.1 g, and Boore and others (1997, solid gray lines) were calculated assuming a reference rock site $V_S30$ of 910 m/sec. The predicted amplification factors from Wong and others (2002; dotted black lines), for rock peak acceleration of 0.05 g, are shown for two different ranges of unconsolidated sediment depth as labeled on the plots. (a) Q01, (b) Q02, and (c) Q03.

**References Cited:**

Boore, D.M., W. B. Joyner, and T. E. Fumal (1997). Equations for estimating horizontal response spectra and peak acceleration from western North American earthquakes: A summary of recent work, *Seism. Res. Lett*. **68**, 128-153.

Borcherdt, R. D. (1994). Estimates of site-dependent response spectra for design (methodology and justification), *Earthquake Spectra* **10**, 617-653.

Wong, I., W. Silva, S. Olig, P. Thomas, D. Wright, F. Ashland, N. Gregor, J. Pechmann, M. Dober, G. Christenson, and R. Gerth (2002). Earthquake scenario and probabilistic ground shaking maps for the Salt Lake City, Utah, metropolitan area, *Utah Geological Survey, Misc. Publ. MP-02-5*, 50 pp., 9 plates.

**Non-technical Summary**:

Site amplification factors describe systematic ground motion differences between soil and rock sites. These factors are used for predicting earthquake ground shaking and for interpolating near-real-time ground shaking maps. There are three different sets of site amplification factors that are widely applied to Utah's Salt Lake Valley. In this study, we used data from Advanced National Seismic System stations in the Salt Lake Valley area to examine the validity of these factors. We conclude that the empirically determined factors fit the observations better than the theoretically developed factors, even though the latter were developed specifically for Salt Lake Valley soils.

**Reports and Publications:**

Pankow, K. L,. and J. C. Pechmann (2004). Determination of low-strain site amplification factors in the Salt Lake Valley, Utah, using ANSS data (abstract), *Basin and Range Province Seismic Hazards Summit II, Program and Abstracts*, Reno-Sparks, Nevada, May 16–19, 2004, 122–123.

Pankow, K.L, and J.C. Pechmann (2004). Determination of low-strain site amplification factors in the Salt Lake Valley, Utah, using ANSS data (abstract), *Eos Trans. AGU* **85,** no. 47, Fall Meet. Suppl., Abstract S43A-0974.

Pankow, K. L., and J. C. Pechmann (2005). Determination of low-strain amplification factors in the Salt Lake Valley, Utah, using ANSS data, in *Proceedings of the Basin and Range Province Seismic Hazards Summit II*, W. L. Lund (Editor), *Utah Geol. Surv., Misc. Publ.*, in press.

**Availability of Data:**

The waveform data used in this study are from ANSS stations operated by the University of Utah, and can be retrieved from the IRIS Data Management Center using their SeismiQuery Web tool at <*http://www.iris.washington.edu/SeismiQuery*> (delivered in a variety of formats).